Associations between Hippocampal Subregions and Episodic Memory in Early Childhood

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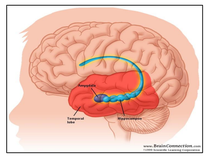
Introduction

- The Children's Memory Scale (CMS) is a well-established assessment of learning and memory in individuals ages 5 through 16. CMS employs a multitude of memory measures (Cohen, 1997) but in the present study we focus on verbal recall (episodic memory).
- Episodic memory is the collection of previously encountered experiences, composed of events, places, and associated emotions. Episodic memory has been shown to gradually advance across childhood development (Riggins, 2014). Thus, it is important to address the brain regions associated with memory formation, specifically the hippocampus.
- The hippocampus, located in the medial temporal lobe, is a small organ in the limbic system of the brain and is thought to be responsible for a multitude of memory processes.
- To date, there is an abundance of literature on hippocampal volume and episodic memory, however limited research exists that utilizes magnetic resonance imaging (MRI) and an assessment like the CMS in young children under the age of 5 (Bauer et al., 2012; Riggins et al., 2015; Riggins et al., 2016). To address this gap, the current study utilized an MRI scan and the CMS assessment on episodic memory to examine the relationship between hippocampal volume and episodic memory in children of ages 4 to 8 years.
- The present study sought to examine memory recall on an immediate, one hour delay, and one week delay on the CMS task and if recall was associated with hippocampal subregion volumes.



Methods

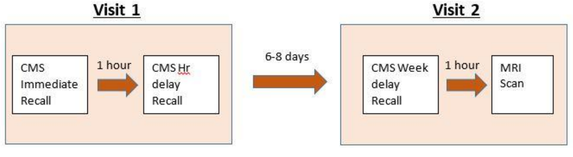
Participants

- The participants were recruited mainly through the Infant and Child Studies (ICS) database and by word-of-mouth. Data was collected from 200 children (100 Male, 100 female) who were between the ages of 4 to 8 years (*M* = 74 months, *SD* = 18 months).
- Analyses were conducted only on data that were coded at the time of this presentation (*n*s = 121-130).

Variables (CMS)	N (total)	N (males)	N (females)	Mean Age (months)	SD Age (months)
Immediate	127	71	56	75.6	17.4
1-hour delay	130	72	58	75.8	17.3
Week delay	121	69	52	75.0	16.8

Behavioral Task

- The participants completed the story recall task from the CMS at two different visits, which occurred 6-8 days apart. Each round of the task was audio recorded for later scoring.
- On their first day, children were told two short stories and were asked to repeat them back exactly as they could remember it, word by word if possible. The stories were only told once by the researcher in the first session, and were not repeated again afterwards.
- The participants were then asked to repeat back the story at three separate times as free recall:



- The participants were scored on "story units"
  - Points for story units: given if the child recalled particular words or phrases from the story.

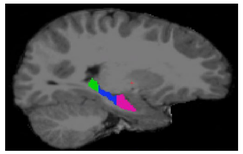
Methods (Con't)

MRI Data Collection

- Anatomical data were collected at the Maryland Neuroimaging Center using a 32-channel coil in a Siemen's 3T Scanner. Volumetric data were derived from MPRAGE scan (.9mm³ voxel).

MRI Data Processing & Analysis

- Freesurfer was used to generate volumes and find boundaries of hippocampal head and tail. ASAT/SEGA adapter was used to refine volume (Riggins et al., 2018).
- The uncal apex and fornix were identified manually to calculate volumes of hippocampal subregions (head, body, and tail).
  - The uncal apex is a common landmark used to differentiate the head and body of the hippocampus (Poppenk & Moscovitch, 2011).
- Raw head, body, and tail volumes were adjusted for head size in each hemisphere (Riggins et al., 2018).

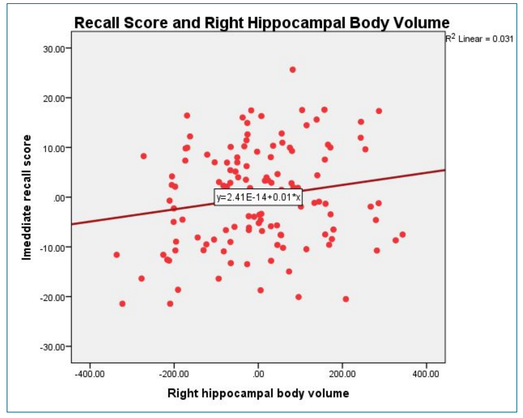


Results

- Three simple linear regressions were calculated to predict CMS immediate scores, 1 hour delay scores, and one week delay scores based on hippocampal subregion volumes.
- A marginally significant effect was found for CMS immediate scores and right hippocampal body only ($F(8,118) = 9.894$, $p = .054$), with an R squared of .401.
- No other significant effects were found for the other dependent variables.
- As expected, age and gender were significant predictors in each model (see table below).

Predictor Variables	CMS immediate	CMS hour delay	CMS week delay
	β	β	β
Right hipp head (adj)	0.130	0.036	0.070
Right hipp body (adj)	0.189	0.092	0.077
Right hipp tail (adj)	0.102	0.126	0.057
Left hipp head (adj)	0.018	0.069	0.029
Left hipp body (adj)	-0.121	-0.050	0.010
Left hipp tail (adj)	-0.135	-0.137	-0.072
Age	0.505***	0.549***	0.597***
Sex	-0.221**	-0.216**	-0.172*
Adj. R^2	0.361***	0.38***	0.415***
F	9.894***	10.893***	11.659***

*$p < .05$, ** $p < .01$, *** $p \leq .001$



Discussion

- This study assessed the relationship between hippocampal subregion volume and episodic memory through looking at CMS and MRI data.
- What made the results in this project unique was the availability of MRI data alongside the CMS scores for young children.
- Data analysis revealed a relation between right hippocampal body volume and immediate episodic memory.
  - This is similar to previous findings and literature that suggests that "performance on episodic memory tasks was related to a larger right hippocampal body" (DeMaster et al., 2013).
  - The evidence suggests that the right hippocampal body plays a significant, specific role in episodic memory, and this applies to early childhood as well.
  - Perhaps, in particular, this subregion is involved in immediate episodic memory, where the delay between stimulus presentation and recall is little to none.
- Future research should look further into the hippocampal subfields (the smaller order internal circuitry such as the dentate gyrus (Riggins et al., 2018) within the subregions to see if perhaps there are volumetric differences on a smaller scale related to episodic memory.
- Furthermore analysis should be conducted once the dataset is complete.
- Lastly, future research should investigate further the differences between delay time in recall and their relation to hippocampal subregion volume.

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